Assessing Inspection Risk

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Rick Campins - Northwest Airlines

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Overview

Introductions

■ Lee Ostrom - Overview of Risk Study

■ Rick Campins - Northwest Airlines
Perspective

Introductions

Lee Ostrom, Ph.D.

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Barbara Kanki, Ph.D.
NASA Ames Research Center

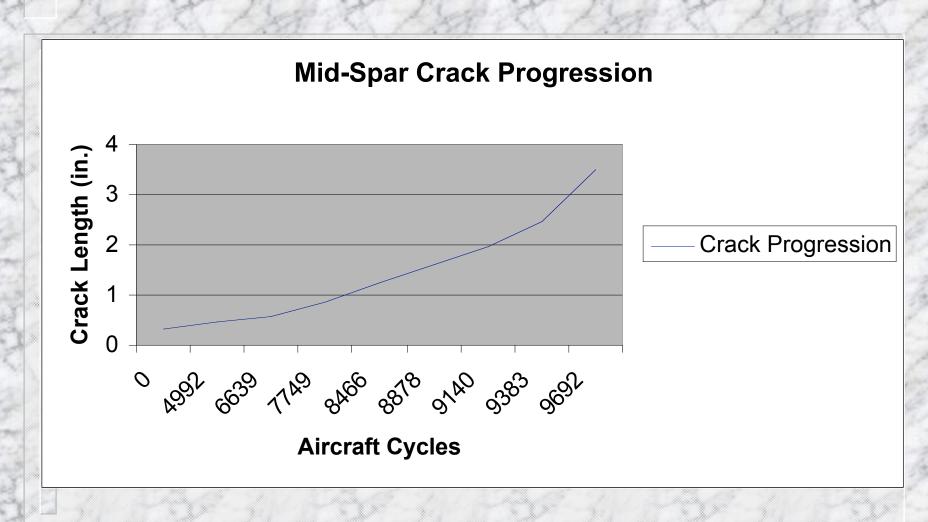
Rick Campins
Northwest Airlines

Inspector Reliability Study

Can inspector reliability estimates be developed from inspection data and crack propagation curves?

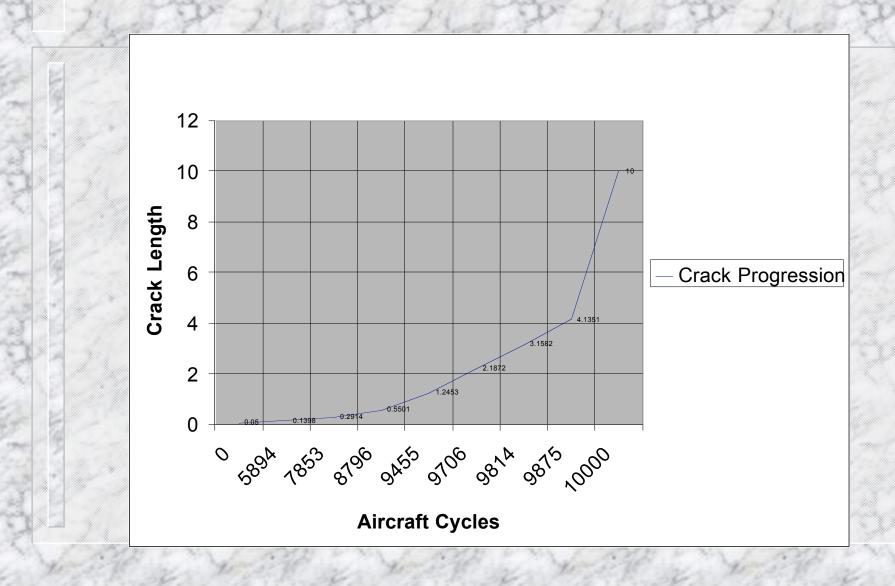
Crack Propagation Curves

Mid-Spar Crack Curve



Includes .25 diameter bolt hole.

Panel Crack Curve



Panel Crack Data

Crack Length at time of current inspection	Cycles in Life of this Crack	Cycles – 1000	Crack Length	Cycles – 2000	Crack Length	Cycles + 1000	Crack Length	Cycles + 2000	Crack Length
.125	4500	3500	-1	2500	.08	5500	.13	6500	.18
.25	7700	6700	.20	5700	.125	8700	.55	9700	1.25
				177.2		177.2			
.375	8186	7186	.22	6186	.13	9186	.875	NA	NA
9									
.50	8700	7700	.25	6700	.20	9700	2.20	NA	NA
Ŕ.									
.75	9100	8100	.375	7100	.22	NA	NA	NA	NA
1.00	9300	8300	.380	7300	.23	NA	NA	NA	NA
2									
1.25	9500	8500	.45	7500	.25	NA	NA	NA	NA
4									
1.5	9600	8600	.47	7600	.25	NA	NA	NA	NA
2.00	9700	8700	.50	7700	.25	NA	NA	NA	NA
200	Mark 1	10	N. Sky	100	1.36	100	M. Sky	100	100

Panel Crack

■ 0.25 Inches at detection - 7700 cycles

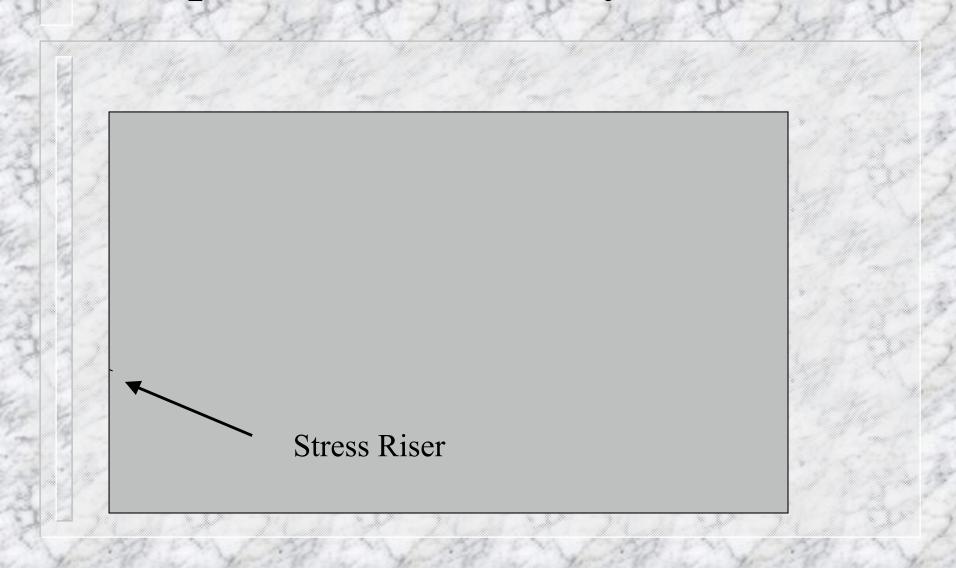
+ 1000 cycles (8700) - 0.55 inches

+2000 cycles (9700) - 1.25 inches

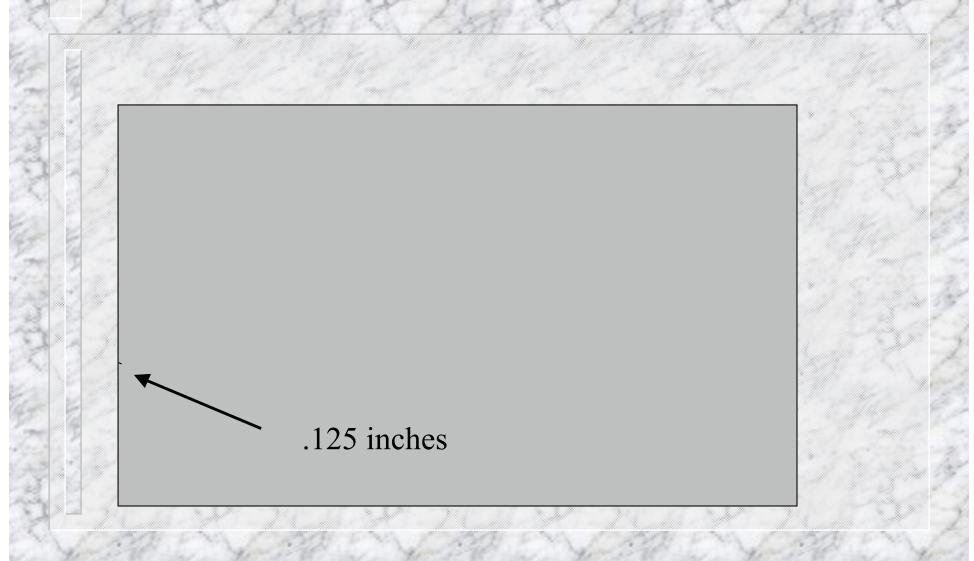
Mid-Spar Crack Data

7680 3120	2000 4380 6680	.11	3380 5680	.13	6380 8680	.29	7380	.40
7680	6680							.40
		.281	5680	.15	8680			
					0000	1.175	9680	2.875
	7120	.375	6120	.25	9120	1.5	NA	NA
3500	7500	.49	6500	.27	9500	2.5	NA	NA
3750	7750	.51	6750	.29	9750	3.5	NA	NA
9100	8100	.75	7100	.375	NA	NA	NA	NA
9314	8314	.9	7314	.48	NA	NA	NA	NA
37	750	750 7750 100 8100	750 7750 .51 100 8100 .75	750 7750 .51 6750 100 8100 .75 7100	750 7750 .51 6750 .29 100 8100 .75 7100 .375	750 7750 .51 6750 .29 9750 100 8100 .75 7100 .375 NA	750 7750 .51 6750 .29 9750 3.5 100 8100 .75 7100 .375 NA NA	750 7750 .51 6750 .29 9750 3.5 NA 100 8100 .75 7100 .375 NA NA NA

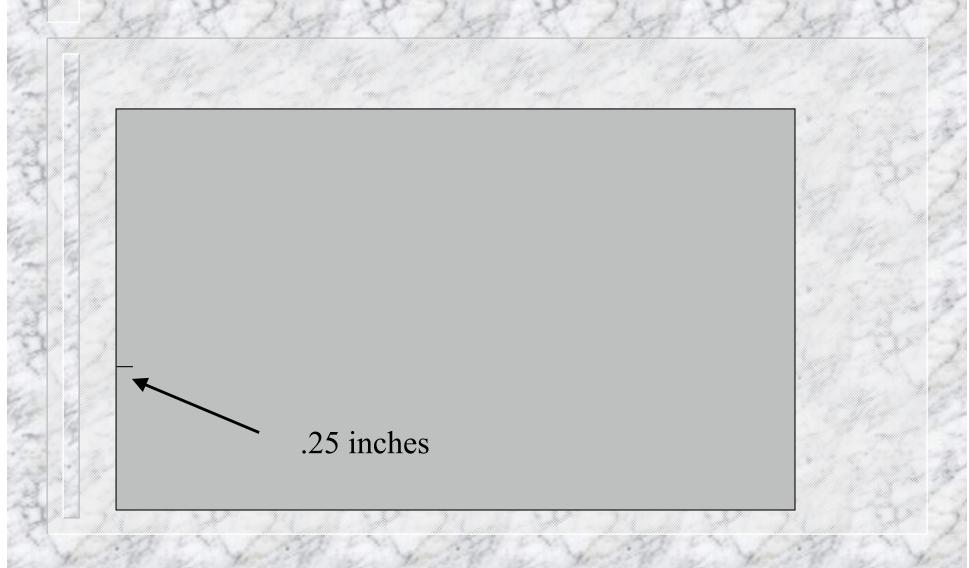
Incipient Crack – 0 Cycles



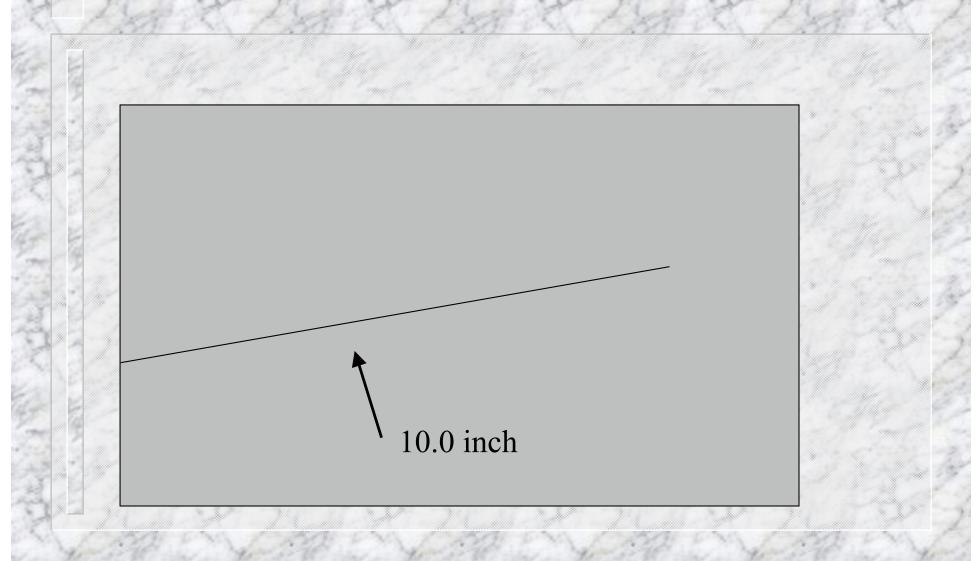
+4500 Cycles



+7700 Cycles



+10,000 Cycles



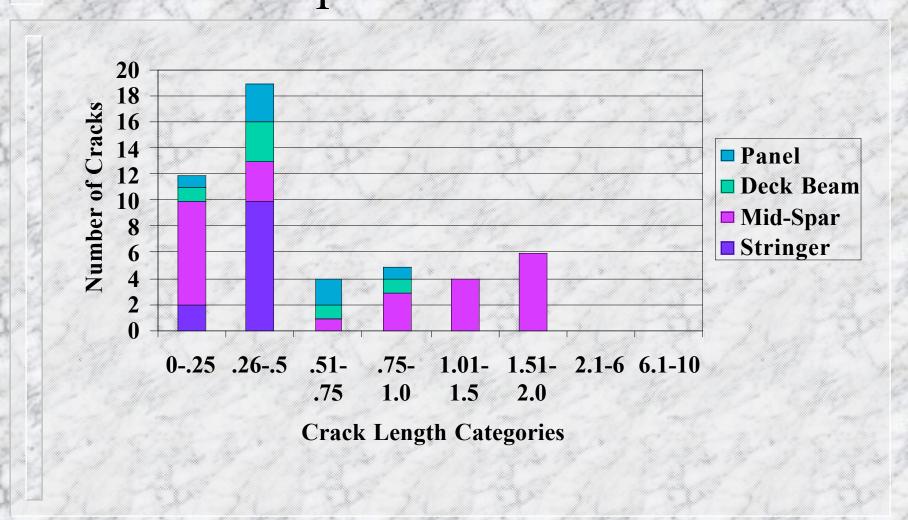
Inspection Data

Over 50,000 data points were reviewed

Only a portion of the cracks detected had lengths associated with them

The cracks were binned into one of five crack types

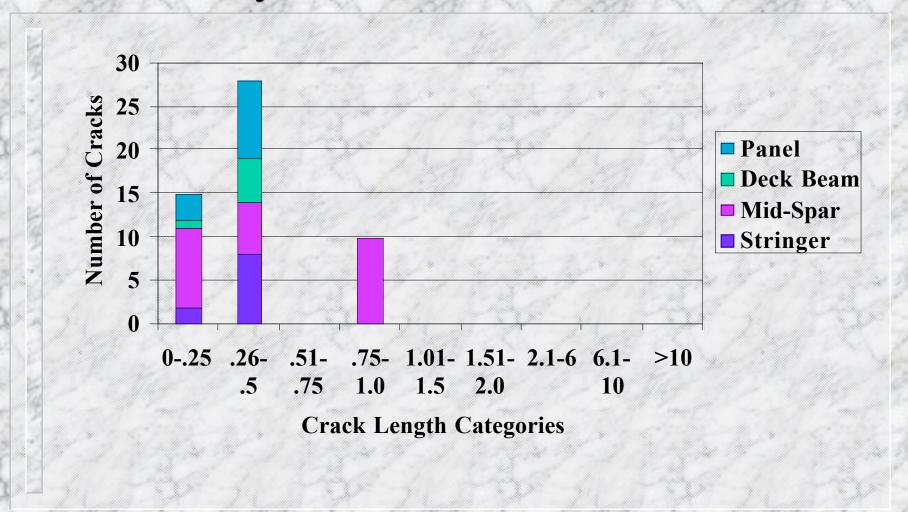
747 Cracks Found Time of Inspection



747 Cracks

- The next slide shows what the lengths should have been, using the Boeing curves to predict the values at minus 1000 cycles (the prior inspection).
- Several of the cracks were not there, however, most were at a smaller length.

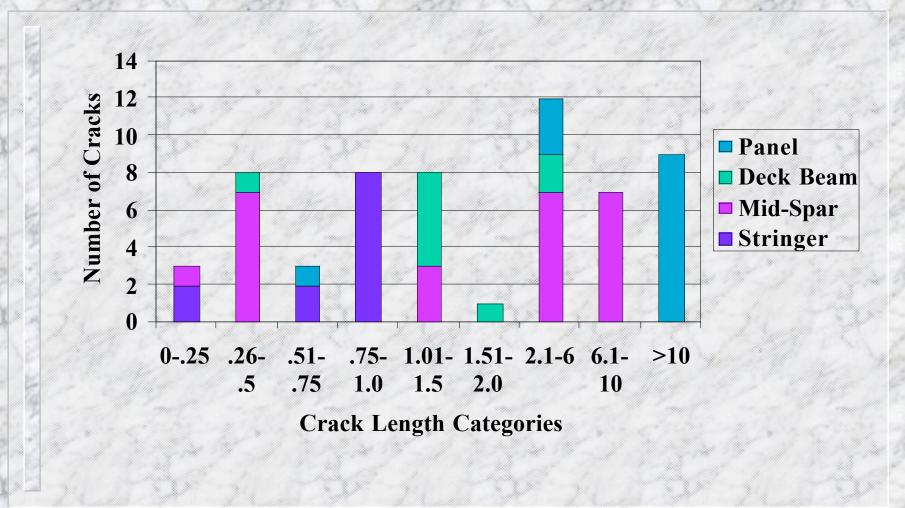
747 Cracks Found- 1000 Cycles



747 Cracks

- The next slide shows what the predicted lengths would be if left to progress another 1000 cycles or to the next inspection.
- Notice that most of the cracks have propagated to a very large length.

747 Cracks Found + 1000 Cycles



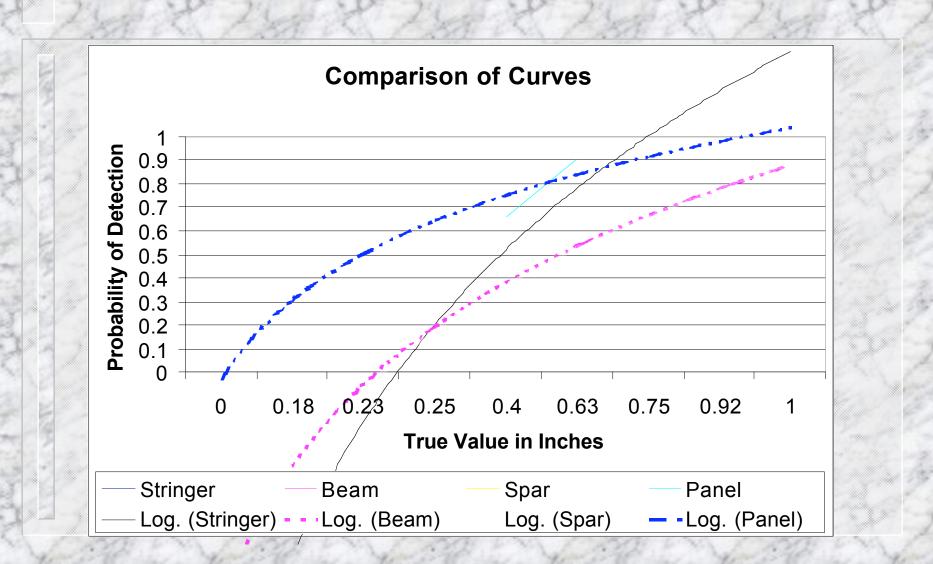
Visual Crack Length Estimation

- A study was conducted to determine how well inspectors estimate crack length
- Three different parts, two colors, three shifts, and 16 different lengths were used
- This study found that inspectors overestimate the lengths of small cracks and begin to underestimate the length of longer cracks

Probability of Detection Curves

 Probability of detection curves were developed from the above information

Probability of Detection Curves



Findings

- We have determined that the probability of detection estimates can be developed from crack propagation curves and inspection data
- Preliminary findings have shown that
 Northwest Airlines' probability of detecting cracks is much better than predicted by the
 OEM

Rick Campins Chief Inspector Northwest Airlines

Northwest Airlines Perspective

Conclusions/Breakout Session

- Why is this important?
- Managing inspection variability
- To better establish maintenance and inspection intervals
- Applicability to other areas of inspection
- This project demonstrates that risk analysis can be applied from a very high-level to a very finite-level of an operation